Reprinted from
School Science and Mathematics
June, 1937

STATE TEACHERS COLLEGE
AT
WORCESTER
MASSACHUSETTS

THE PREPARATION OF TEACHERS OF MATHEMATICS FOR JUNIOR AND SENIOR HIGH SCHOOLS

BY WILLIAM B. ASPINWALL
President State Teachers College, Worcester, Massachusetts

There was a time, which is still within the memory of some of us, when it was assumed that an adequate knowledge of subject-matter and the confidence that came with the acquisition of a college degree were all that were needed to teach successfully in the high school. There was an opinion accepted more or less generally, which approximated the assertion made by a recent writer that "if an individual had brains enough to 'get through' college, he had intelligence enough to teach." But during the last quarter-century or a bit more, changes have taken place which have definitely affected the high school situation. We at the State Teachers College at Worcester have felt that our observation and experience justify the belief that there has been a strong and clearly discernible educational movement in the direction of greater faith in the efficacy of professional preparation of teachers for the secondary school. The traditional curriculum of the secondary school does not hold the dominant place that it once held. The high school is still the people's college and must provide for the majority of its students their final cultural preparation for life. For most high school students, therefore, preparation for college entrance can not be accepted as the chief objective of high school education. Furthermore, the study of psychology and of the meaning and processes of education has changed the traditional conception of what is needed properly to equip the teacher for his work. Mastery of a subject is still essential, but it does not carry with it the presumption of skill to teach it. Professional training for teaching is seen as no more illogical than the vocational preparation of those who seek to enter other fields of work. The establishment of departments of education in the liberal arts colleges bears evidence of this belief, as does the fact that there is an increasing number of teachers colleges that are undertaking the preparation of high school teachers. We are persuaded, therefore, that it is now almost universally believed that better high school teaching can be done if adequate professional education and training are required to supplement the mastery of subject matter.

Acting, therefore, upon these beliefs, we entered upon the task of preparing teachers for secondary schools twelve years ago. We organized and developed courses in six different fields,* one of which is mathematics, and we have been striving during these years to make the preparation in this field adequate to the needs of high school teachers. In determining the character and extent of the preparation needed for this purpose, we were guided by the opinions and standards of secondary school teachers themselves. We were not called upon to consider the requirements for certification of teachers, since Massachusetts does not have any state law requiring certification. We were not influenced by the requirements of any accrediting association, but we did base our judgment on a study of the deliberations of the secondary school teachers themselves. We did this not only in the case of teachers of mathematics but in the case of the teachers in other fields too, and as a result of that study we set up the minimum standard for a major study in any field at not less than 24 semester-hours of work, taken through the four years, with student-teaching additional. For the preparation for teaching mathematics, we have required 26 semester-hours of study in mathematics, and in addition have prescribed an introductory course in science; an introductory course in economics and adequate cultural training outside of the field of mathematics and the above related fields. This cultural work includes definite courses in English language and literature, American and European history, sociology, education and fine arts. Admission to the courses in mathematics is conditioned upon the satisfactory completion of the usual three years of high school study of mathematics, unless by reason of special conditions, the instructor is satisfied with a slightly different preparation, or is convinced that a student's preparation is such that he can profit by major work in this field. It is gratifying to note, however, that only rarely has any student entered this field of preparation with less than the usual high school courses in mathematics. Those who are ambitious to teach mathematics have usually made up their minds to do it while still students in the high school and have, therefore, taken in the high school all courses which will contribute to their preparation for teaching. Furthermore, it has been our observation that usually those who have liked mathematics sufficiently to take it throughout the high school course and then to continue its study through four years of college have been students of high standing and ambitious to attain excellence in scholarship.

---

* Latin, French, English, History and Social Studies, Geography and Mathematics.

Although in the four years of college work, a student of mathematics is required to take courses of far broader scope of subject-matter and much more advanced in character and difficulty than those which he will be required to teach in the high school, nevertheless we have believed that four full years of the study of mathematics should be required, not only for the sake of the scholarship and training involved, but because that amount of subject-matter preparation was, we found, the accepted standard or possibly the ideal, of some groups of secondary school teachers.

To provide, therefore, for these students of mathematics who are preparing to become teachers of mathematics in Junior and Senior High Schools, a program of college courses of study covering four years is offered. This program comprehends: (1) courses in advanced subject-matter, taken through the four years; (2) acquaintance with the history and philosophy of mathematics; (3) review of the mathematics of the secondary school; (4) study of the teaching of mathematics; (5) actual student-teaching of mathematics under supervision; (6) assembly exercises based upon studies in mathematics. In this paper I will briefly outline the work done in these different lines.

1. COURSES IN MATHEMATICS

Five courses, aggregating 26 semester-hours of credit, are required in this major study; in the first year, college algebra and solid geometry; in the second year, plane trigonometry and analytical geometry, together with a professional course in mathematics for the secondary school; in the third year calculus; and in the fourth year, mathematical theory, including the history and philosophy of mathematics and methods of teaching. The chief and underlying purpose of these courses of study is informational, cultural, and disciplinary. It undertakes to enlarge the student's knowledge and understanding of the field of mathematics; to quicken his intellectual interest in its character and its power; to give him a keen appreciation of the processes of thought required and their important relations to the life of everyone, as well as to develop in him skill in making use of this mode of thinking. It should result in exactness of statement, in definiteness of speech, in clear, precise and logical thinking, and in a profound respect for accuracy and truth. It should enable the prospective teacher to gain a realization of the broad scope of mathematics and its almost limitless applications in present day life, and at the same time an understanding of the relationships among the narrower divisions of the subject as studied in the high school.

2. ACQUAINTANCE WITH THE HISTORY AND PHILOSOPHY OF MATHEMATICS

The teacher of mathematics needs something more than a mastery of subject-matter and skill in the processes of the subject, even though the scope of subject-matter is much more extensive than will be required in the actual courses which the high school teacher will be called upon to teach. He needs also an understanding and an appreciation of the significance of the mathematical mode of thinking, and a knowledge of the historical development of the subject. It may be said that a mastery of a subject implies a knowledge of its history and philosophy. If so understood I will accept that understanding, but I do not think that is usually taken for granted. For that reason I wish to make special mention of the need of this knowledge. To know the origin and development of mathematical terms, processes and symbols, the growth and establishment of mathematics as a mode of thinking, its evolution through the years, its significance in the progress of civilization, its importance to science and to the thought processes of the past and of the present; its essential relationship to an adequate interpretation of life—to have an understanding of these aspects of mathematics is to possess an expert knowledge of the subject and an intimate acquaintance with its meaning and value, which will go far toward making the teacher more than usually capable in his field. We believe that as much as possible should be done for the student in giving him an understanding of these aspects of his field. The more thoroughly he knows them, the better teacher he will be, and without a good grasp of them, he cannot hope to become more than a drill-master.

3. REVIEW OF THE MATHEMATICS OF THE SECONDARY SCHOOL

Either immediately preceding the study of the methods of teaching mathematics or simultaneously with that study, a rapid review is made of secondary school mathematics, particularly algebra and geometry. From the college student's more mature point of view, and in the light of added mathematical knowledge, the student gains from this study a new understanding of mathematics. Perhaps for the first time, and certainly more clearly than ever before, he has a realizing sense of the meaning of mathematics and the value and purpose of teaching it. He sees the symbols and formulas as signs representative of something more profound; viz., the logic, the method, the way of thinking or reasoning that underlies them; he appreciates the place and value of accuracy in reading, in observation, in computation, in recording; he realizes the need in all our thinking of arrangement and order and system; and even recognizes the influence of the mathematical idea, once grasped, upon our use of language, our clearness of purpose, our standards of achievement, our reliability of judgment. This review adds to the feeling of mastery on the part of the prospective teacher; it serves to strengthen the foundation of his scholarship and gives him in a renewed acquaintance with a field of study already studied and acquired, the necessary equipment of familiar knowledge and a confidence in that knowledge which is reinforced by the added knowledge of advanced mathematics, all of which serves to enable him to approach his work as a secondary school teacher with far greater prospect of success.

4. Study of the Teaching of Mathematics

An important part of the preparation for teaching mathematics is the student-teaching under supervision. Immediately preceding this experience, special attention is given to the study of the teaching of mathematics. While the mastery of the subject-matter is one essential, it is not the sole essential. We believe that there is needed also an understanding of psychology and the laws of learning; an acquaintance with the scope, content and organization of the courses in mathematics offered in the secondary school; a knowledge of the methods of teaching that are adaptable to this field and of the appropriate presentation and conduct of various types of lessons; of the effective use of illustrative materials and an ability to judge and to use textbooks and reference books. By reason of this training in methods of teaching the student should gain some ability to analyze teaching problems and situations that arise, and to be able to employ the appropriate procedures in their solution. In short he should acquire a definite understanding of the processes of teaching upon which teaching skill may be successfully built.

5. STUDENT-TEACHING OF MATHEMATICS UNDER SUPERVISION

This experience of actual teaching of a subject is, in our opinion, an essential part of the preparation of a teacher. It is as necessary as the interneship in the preparation of a physician or of an apprenticeship in the preparation of a mechanical engineer. For more than a half-century we have had the privilege of furnishing our students this experience in the public schools of Worcester. We have had a friendly arrangement with the city school authorities whereby our students are given the opportunity of teaching regular classes under the normal conditions of the school. They do this under the instruction and general oversight of our own supervisors; and during a period of 9 weeks in the junior year, they are given full charge of the daily class work in the subject that is assigned to them. We have also a small training school of our own, of junior high school grades, in which they do the full instruction. Here they teach their major subjects for a period of 12 weeks in their senior year. Their teaching is observed by the supervisors as frequently as possible, usually every day in the training school; and is followed by an individual conference for criticism and instruction. The supervisors direct the making of lesson plans, examine the written work, and guide the training of the student-teacher in such matters as determining aims, questioning, learning the different types of lessons and the appropriate procedures in conducting them. By this practical experience under natural teaching conditions, the students make rapid progress in the development of their teaching ability; their scholarship is tested; they gain a new understanding of the subject-matter which they teach, and how to organize it and present it; they acquire the teacher's point of view and an ability to evaluate good methods of teaching; they are enabled to appreciate the problems of management and to understand the value of maintaining attention and interest. In our judgment this experience of student-teaching is one of the most valuable factors in the preparation for teaching, and we believe that it contributes immeasurably to the promise of success to those who look forward to teaching mathematics in the secondary school.

6. ASSEMBLY EXERCISES BASED ON STUDIES IN MATHEMATICS

As a factor in the preparation for teaching any subject, the value of training in speaking from the platform before the assembly of students is very great. Such practice makes for growth in ease, precision and effectiveness in speech. We strive, therefore, to give opportunity to the students in all departments of our work to get this practice. Those who major in mathematics participate in it and give frequent programs illustrative of their studies. These programs comprise chiefly the reading of papers, with or without charts, and the use of illustrative materials; also discussions of individual investigations, of the scientific and industrial applications of mathematics; of the origins and the development of formulas, symbols and ideas; also the reporting of particular cases of teaching problems experienced by the students in their teaching practice, and other significant phases of this important subject. It is our conviction that it is valuable training and we believe that it is highly regarded as such by the students themselves.

By this brief outline it has been our aim to give a general understanding of the extent and character of the preparation afforded in this institution for the teaching of mathematics in secondary schools. The quality of the work done in any field is affected in no small degree by the instructors in charge of it. It is no less true in this case. The work in this field is conducted by two instructors who are familiar, by teaching and administrative experience, with the conditions of high school teaching, and who are interested in contributing to their improvement. They are both enthusiastic teachers, who take pride in their chosen field of teaching; scholarly in their approach to the subject and in their conduct of it, thoroughly prepared, broad in their views and possessing the highest standards for teacher-training work. They are qualified to fit the work in training to the needs of the prospective high school teacher of mathematics, and the outcomes of their instruction may be described in brief as follows: An adequate understanding of the subject-matter of the field of mathematics; an appreciation of its significance in the life of today; an acquaintance with the theory and problems of teaching it; and a proved ability to teach it in the secondary school. Those of our graduates who have majored in this field and have undertaken this preparation for the teaching of mathematics have, we believe, gone out with an excellent promise of success.